

Nuclear Astrophysics Working Group

Summary of FRIB Workshop May 30-31, 2009 held at ANL

Conveners: Jeff Blackmon, Ken Nollett, Hendrik Schatz

Goals:

The Nuclear Astrophysics Working Group met for 2 hours. The goals of the meeting were:

- Reaffirm science case for nuclear astrophysics at FRIB
- Create awareness in the community of ongoing equipment development projects and existing ideas for FRIB equipment to create opportunities to broaden existing collaborations and trigger the formation of new ones.
- Discuss and prioritize equipment needs for a FRIB nuclear astrophysics program
- Discuss facility requirements for FRIB nuclear astrophysics program
- Discuss the organization of a nuclear astrophysics users group

Program:

The program consisted of a set of short oral presentations (10 min) with interspersed discussion, and a discussion period at the end.

The oral presentations were (In cases a title was not given we generated one that summarizes the contents):

- "Key Questions in Astrophysics for the FRIB Era", Jim Truran
- "ISLA Spectrometer", Daniel Bazin
- "Active Target – TPC", Abigail Bickley
- "LEND and Charge Exchange Reaction Studies", George Perdikakis
- "Decay Spectroscopy for Astrophysics", Sean Liddick
- "Recoil Separators for Capture Reaction Measurements", Michael Smith
- "SECAR: Recoil Separator for Astrophysics", Manoel Couder
- "(alpha,p) (p,p) and (p,alpha) measurements at FRIB with ANASEN", Jeff Blackmon
- "Measurements of (alpha,p) reactions with HELIOS", Ernst Rehm
- "Gas Jet Target and indirect reaction rate measurements", Uwe Greife

Findings:

The science case for a nuclear astrophysics program with radioactive beams was reaffirmed, noting that rapid progress in astronomy and astrophysics often drives the need for new nuclear physics input for our astrophysics simulations. Close interaction between nuclear physics and astrophysics during development and execution of the science program is therefore required.

The highest equipment priority for the FRIB nuclear astrophysics program is a dedicated nuclear astrophysics recoil separator optimized for the direct measurement of charged particle capture reactions at astrophysical energies.

A critical facility requirement for the nuclear astrophysics program is the delivery of high intensity ($> 10^8$ pps), low energy (< 3 MeV/u), high quality reaccelerated beams of rare isotopes often near stability. This capability is essential for a program of direct cross section measurements with a recoil separator.

In addition, the nuclear astrophysics program will take advantage of the fast, stopped, and reaccelerated beams provided at FRIB using a wide range of dedicated equipment, as well as equipment that is shared with the nuclear structure and reaction programs. While some of this equipment was presented at the meeting, this is clearly not an exhaustive list. Some equipment is already funded, but other important pieces are still in the conceptual or proposal stage. While there is some overlap of requirements for nuclear astrophysics experiments and nuclear physics experiments, in many cases there are significant differences. It will be important for nuclear astrophysicists to be engaged in these other equipment projects. In that respect a concern was raised about running the astrophysics working group in parallel to other equipment relevant working groups. This should be addressed in future workshops.

The group agreed to form a **nuclear astrophysics user group** at FRIB that includes a broad range of experimentalists interested in various FRIB experiments, as well as theorists working at the interface of nuclear physics and astrophysics.